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Large-scale bioenergy production from soybeans and switchgrass in Argentina Part A: Potential and economic feasibility for national and international markets

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ABSTRACT

This study focuses on the economic feasibility for large-scale biomass production from soybeans or switchgrass from a region in Argentina. This is determined, firstly, by estimating whether the potential supply of biomass, when food and feed demand are met, is sufficient under different scenarios to 2030. On a national level, switchgrass has a biomass potential of 99×10^6 (1.9 EJ) to 243×10^6 tdm (4.5 EJ)/year depending on the scenario. Soybean (crude vegetable oil content) production for bioenergy has a potential of 7.1×10^6 (0.25 EJ) to 13.8×10^6 tdm (0.5 EJ)/year depending on the scenario. The most suitable region (La Pampa province) to cultivate energy crop production is selected based on a defined set of criteria (available land for biomass production, available potential for both crops, proximity of logistics and limited risk of land use competition). The available potential for bioenergy in La Pampa ranges from 1.2×10^5 to 1.8×10^5 tdm/year for soybean production (based on vegetable oil content) and from 6.3×10^6 to 18.2×10^6 tdm/year for switchgrass production, depending on the scenario. Bioenergy chains for large-scale biomass production for export or for local use are further defined to analyse the economic performance. In this study, switchgrass is converted to pellets for power generation in the Netherlands or for local heating in Argentina. Soybeans are used for biodiesel production for export or for local use. Switchgrass cultivation costs range from 33–91 US$/tdm (1€ = 1.47 US$ based on 19 February 2008). Pellet production costs are 58–143 US$/tdm for local use and 150–296 US$/tdm until delivery at the harbour of Rotterdam. Total conversion costs for electricity in the Netherlands from switchgrass pellets range from 0.06–0.08 US$/kWh. Heating costs in Argentina from switchgrass pellets range from 0.02–0.04 US$/kWh. Soybean cultivation costs range from 182–501 US$/tdm depending on the scenario. Biodiesel production costs are 0.3–1.2 US$/l for local use and 0.5–1.7 US$/l after export to the Netherlands. Key parameters for the economic performance of the bioenergy chains in La Pampa province are transport costs, cultivation costs, pre-processing and conversion costs and costs for fossil fuels and agricultural commodities.

Contents

Abbreviations: ARG, Argentina; BA, Buenos Aires; BB, Bahía Blanca; FCE, Feed Conversion Efficiency; GDP, Gross Domestic Product; MS land, moderately suitable land; mS land, marginally suitable land; NL, the Netherlands; S land, suitable land; PPI, Producer Price Index; ROT, Rotterdam; VS land, very suitable land.

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1. Introduction

Many energy scenarios and policy objectives indicate a growing increase in the production and use of biomass as an energy source [1]. Without further development of biomass energy resources (e.g. through energy crop plantations and better use of residues) and a well functioning biomass market to assure a reliable and lasting supply, the often ambitious targets for bioenergy use may not be met [2].

Several studies [3,4] show that there are some key regions in the world that have a short and long-term underutilized potential for bioenergy production. These regions show a technical potential for using residues as well as possibilities for bioenergy production using dedicated plantations. One of these key regions is the Mercosur which includes Argentina.

On the other hand, there are countries, like the Netherlands, that have insufficient land to meet its projected bioenergy demand. In this case, the development of truly international markets for biomass is essential to meet the country's demands. New trade flows may offer multiple benefits for both exporting and importing countries. For example, exporting countries may gain an interesting source of income and an increase in employment from sustainable biomass production. To be able to realize a well functioning biomass market with a reliable and lasting supply, it is important to determine the economic feasibility of biomass production on the short and longer term in a sustainable manner.

Argentina is in this study chosen as biomass producing country, first, because of its favourable climate and soil conditions for growing biomass. Second, low land and labour costs are beneficial for achieving low bioenergy production costs. In addition, Argentina's existing infrastructure and human resources facilitate the production and transportation of bioenergy. The Netherlands is selected as importing country in this case study. Biomass is the most important source of renewable energy in the Netherlands [5]. A 30% contribution of biomass (around 1000 PJ of primary energy) to the national energy and material supply is expected after 2030 [5], which requires imports from abroad [6].

The study focuses on two different energy crops: soybean and switchgrass. Large-scale cultivation of these crops is based on current and more advanced production technologies. Soybean, as an annual crop, is currently the principal crop and the main export product in Argentina [7]. Several experts in Argentina [8–11] confirm that soybean is one of the more promising crops in Argentina for bioenergy production. In this study, soybeans are converted to biodiesel for export to the Netherlands or for local use. Switchgrass, a C4 perennial grass, is the second energy crop selected for this study and largely unknown in Argentina as energy crop. Switchgrass is mainly used in Argentina for forage production for livestock [12]. The potentially high yields and high contents of lignin and cellulose, generating a high heating value, makes switchgrass attractive for bioenergy production [13]. Combined with the fact that 77% of the agricultural land in Argentina is dedicated to permanent pasture [14], it suggests that this grass can be an interesting option for bioenergy production in Argentina too. In this study, we consider switchgrass conversion to pellets for export and use for power generation in the Netherlands, or for the local market using switchgrass pellets for heating.

The economic feasibility for large-scale export of biomass or biofuels from soybeans or switchgrass from a region in Argentina is determined firstly by estimating whether the potential supply of biomass, when food and feed demand are met, is sufficient under different scenarios. Beside the biomass potential, other factors such as logistics also play a role in the feasibility of large-scale export of biomass pellets or fuel. Therefore, in this study a promising region of Argentina is selected that show the best potentials to develop large-scale biomass production. After the selection of a promising region, the bioenergy chains for large-scale export (and for comparison local use) of the biomass fuels are more precisely defined to allow an investigation of the economic performance. Consequently, the economic feasibility is determined for large-scale biomass production from soybeans and switchgrass in the selected region in Argentina.

2. Key characteristics of Argentina

Argentina is the second largest country of Latin America with a total land area of 273 million hectares. The country is divided into 23 provinces and one autonomous city, the capital city Buenos Aires [15]. The total population of Argentina is around 36 million people (2001), of which almost 90% are living in urban settings. Despite the economic crisis of 2001/2002, Argentina's economy (with a GDP of 182 billion US$ in 2005) is one of the largest in Latin America [16]. While agriculture contributes only 8% to the national GDP in 2007, around 55% of the value from export originates from the agricultural sector [17]. Soybean and soybean derivatives represent the majority (51% in 2003) of the Argentine agricultural export [18].